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Early Mobilization in PICU: Are We on Time?

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Abstract

Purpose of review Elements based on specific literature to assist in the elaboration of an early mobilization (EM) protocol for severely ill children in a pediatric intensive care unit or in an inpatient care unit.
Recent findings Recent findings have shown that immobility during critical periods of the disease may cause physical, neuromusculoskeletal, metabolic, cognitive, and psychological sequelae that may extend throughout life. Prolonged bed rest is associated with thromboembolic events, decreased protein synthesis and muscle mass, and increased risk of death. Children surviving from serious illnesses have an increased risk of delay in overall recovery, resulting in poor quality of life and increased costs of post-discharge health services in the short, medium, and long term.
Summary Further research is needed to delineate protocols for specific populations in PICU as well as to find associations between interventions in PICU with EM, and with outcome times spent in PICU and hospital, need for care after hospital discharge, death and quality of life, among others.

Introduction

Prolonged bed rest is associated with thromboembolic events, decreased protein, and muscle mass synthesis, as well as an increased risk of death [1, 2]. Children surviving serious illnesses have an elevated risk of prolonged weakness, functional impairment, and delayed overall recovery, resulting in poor quality of life and high costs of health services after hospital discharge [3, 4].

Functional impairment may persist after PICU hospitalization, with one-third of the functional impairments detected at the time of hospital discharge. Other 13% of the functional alterations are detected within 2 years after their discharge from PICU [5•], during follow-up.

With the change in the epidemiological scenario, where the advances in knowledge and technology allowed the increase of survival in neonatal and pediatric patients, a group of surviving children and adolescents with complex chronic condition (CCC) is emerging, requiring continuous multiprofessional care and hospitalization. This patient profile was 3.4 times more likely to be hospitalized (86 vs. 27 high per 1000, $p \leq 0.01$) and remained 7.0 times longer hospitalized (552 vs. 90 days per 1000, $p \leq 0.01$) [6] in developed countries, as well as in the USA. In developing countries, and Brazil too, the incidence rate of hospitalizations of children and adolescents with CCC is 331 cases per 100,000 inhabitants [7].

In consonance with this context, some questions are raised: would early mobilization (EM) prevent the CCC from worsening? Should specific EM programs be developed for CCC patients? A severe acute illness, associated with the need for long-term PICU admission, may determine an unfavorable clinical course, changing the survivor to a CCC. Is the multiprofessional health team prepared for the design, implementation, and monitoring of EM protocols according to the needs of each group of patients?

Thus, we believe that when the multiprofessional team that works in this scenario, especially the physiotherapists, takes the lead in the elaboration, implementation, monitoring, and continuing education of their professionals, they will be able to tailor protocols for EM of children and adolescents based on scientific evidence, and orient themselves based on the individualized needs of the patient. However, elaborating a protocol and ensuring that it is applied and monitored is a great challenge because it involves multiprofessional participation in health, as well as contracts/agreements between hospital sectors and departments and, above all, cultural changes.

Definition of EM in pediatrics

Early mobilization has been defined in previous studies [8, 9] as any physical activity sufficient to promote acute physiological effects that increase pulmonary ventilation, central and peripheral perfusion, circulation, and muscle metabolism in the patient's condition. It refers to any mobility intervention performed within 48 h of admission to an intensive care unit [6–8]. However, during the first 48 h of PICU admission, it is difficult to initiate EM in the pediatric age group, since during this period, seriously ill children are seen by the clinical care team as being too sick or in a very unstable condition to be manipulated or handled.

With this in mind, Cameron S et al., 2015 [10] propose that the onset of EM of children should occur within the first 2 to 5 days of diagnosis of the serious illness or problem that led the child to be admitted to the PICU. Joyce CL et al. (2018) [11••] recently suggested the following definition for EM in PICU "EM was defined as the implementation of therapeutic interventions aimed at after hospital discharge. Patients within 72h of their PICU stay, including those patients on positive pressure and mechanical ventilation," determining the EM start time within 3 days of admission to the PICU. However, to affirm that EM is a set of interventions to promote walking may not be adequate for pediatrics, since the age range of admission to PICU usually varies from 1 month to 17 years of age, and deambulation is not the ultimate goal for infants, for example. Thus, it is suggested to use "set of interventions aimed at mobility".

Hence, it is suggested to use the following definition of EM in pediatrics "mobility interventions initiated within 72h of admission to the PICU, intended for children and adolescents in spontaneous breathing or in invasive or non-invasive ventilatory support."

Differently from adult patients, children are more complex from the point of view of mobilization and mobility interventions as their chronological age, cognitive development, and besides level of sedation must be respected. These characteristics associated with the pathophysiology variability, that can affect the seriously ill child, denote a heterogeneous population, which requires specific protocols of evidence-based EM [12].

Barriers to initiate EM

The following barriers to the implementation of EM in PICU are described in the literature: functional and

cognitive deficiencies of the patient common in critically ill children; the scarcity of scientific evidence to guide the safety of EM in PICU, such as the lack of practical guidelines and randomized controlled studies evaluating the risks and benefits of EM in each age group; limited human resources and appropriate equipment; the difficulty of identifying the timing of beginning/middle/end of interventions; the need for medical prescription, which requires an increase in multiprofessional communication in a more agile time; refusal from the family to allow the protocol, usually due to lack of knowledge and/or lack of orientation; restricted physical space; lack of institutional campaigns that publicize the importance of EM; the need for cultural change; lack of knowledge and training of the multiprofessional team; failure to assess pain and discomfort in children; lack of interest; lack of funding; lack of determination from the leadership to implement the EM process [1, 11••, 13]. In addition to these factors, sedation guidelines are not routinely applied in the PICU, making it difficult and/or delaying the onset of EM [1, 14••].

Some barriers are related to the patient's condition, such as clinical instability; the difficulty in the clinical diagnosis and the severity of the disease; the risk of displacement of devices (e.g., catheters and intratracheal cannula); excessive and/or inadequate analgesic dosage; physical constraints; obesity; inadequate nutritional status; lack of motivation in some children to participate in EM activities [1, 15••, 16••].

It is possible to see that most of the barriers described in previous studies [16••, 17••] include situations that may change the culture and/or the routine, which are related to the form the patient is handled in PICU. Along these lines, the individualized multiprofessional discussion per patient is suggested to evaluate the risks versus the benefits to the beginning of the EM interventions, knowing that it is possible to institute several levels/degrees of EM (from passive to active mobilization of the patient), and that less functional positioning can be adopted even in severely compromised patients, that is, some level of intervention is always possible, aiming at the patient's functionality and the prevention of complications inherent to immobilism.

Facilitators for EM in PICU

In general, the involvement and strategic planning of the multiprofessional team is considered to be a facilitator for the implementation of protocols for EM. In order to carry out a division of tasks [18], as well as the family's trust in the health team, an active participation of each family is necessary; the involvement of the team in the common desire to start activities aimed at the mobility of the child; and the belief that physical activity is important and should be started as soon as possible to accelerate the child's recovery process [16••].

Specifically for patients supported by the extracorporeal membrane oxigenation (ECMO), some facilitators such as optimized nutritional support, the adequacy of sedatives/analgesic drugs (minimum sedation to enable active movement), together with the use of a double lumen cannula whenever this is possible [19], may help in starting EM.

The involvement of a multiprofessional team is always suggested, together with the patient's family and caregivers, making the role of each one of them clear enough in the process [20•, 21] to provide the protocol of EM.

Indications of EM in PICU

EM may be indicated for children from 1 month of life to 18-year-old adolescents hospitalized for a period longer than 48 h and without clinical contraindications [14••, 22, 23]. It may also be indicated for all patients with deep venous thrombosis after initiation of anticoagulation, for children using parachute blood-pumping devices [18], for individuals with advanced cystic fibrosis [19], and other clinical situations.

It is suggested that every child and adolescent with PICU hospitalization time of 48 h should be inserted into an EM protocol. Clinical stability and use of ventilatory support should be considered to determine the level of requirement for patient mobilization [14••, 21]. It is suggested to follow the criteria of indication of the EM proposed by Wieczorek B. et al. [14••], which offer three levels and tiered activity plan considering the clinical condition of each patient.

When to start EM

The majority of studies [10, 14••, 21] suggest that the mobilization should be initiated between 48 and 72 h of admission to the PICU and only after the cardiorespiratory stabilization of the patient is achieved. However, in specific clinical situations, the guidelines should be followed, even if they are still divergent, such as in the EM protocols for the prevention of thromboembolic events, in which it is suggested to begin deambulation immediately after the start of anticoagulation therapy, as well as a waiting period between 48 and 72 h to initiate the interventions [24].

It is suggested that all patients should be evaluated for the feasibility of initiating supervised physical activity within 24 h of admission to the PICU [17••]. We have added to this suggestion the need to determine an individualized mobility protocol, considering neuropsychomotor development (NPMD), mainly for infants and children up to 24 months of age, as well as a set of safety criteria.

In another model of care [20•], an evaluation with a physiotherapist is suggested whenever the length of stay of the child in the PICU is expected for more than 3 days or 1 week in a general hospitalization unit. Children with NPMD delays should have a physical therapy appointment on admission. The main objective of the assessments is to identify risk factors for NPMD delays or loss of functionality, so that preventive measures are taken.

It is recommended that every PICU patient should be evaluated on admission by a physiotherapist, regarding the possibility for participation of an EM protocol [17••], as well as it is beginning within 3 days at the PICU, establishing levels/degrees of complexity according to their clinical condition and functional capacity [11••, 14••].

Safety and feasibility

Early mobilization of severely ill children in PICU may be associated with potential risks and complications. These include hemodynamic instability, accidental displacement of tubes, and vascular accesses, falls, pain, anxiety, and frustration [21]. However, several studies have shown that EM in PICU is safe and feasible, given some appropriate precautions, in various clinical situations [14••, 18, 23, 25].

The contraindications for EM suggested in previous studies are not fully established in the literature, such as hemodynamic instability, negative energy balance and increased catabolism [18], increased intracranial pressure, and uncorrected coagulopathies [13]. In view of the suspicion of venous thrombosis, EM before the onset of anticoagulation therapy is contraindicated [24].

Some adverse effects to EM were cited, such as musculoskeletal injury, pain or discomfort, increased need for sedation and analgesia, arrhythmias, persistent tachycardia, hypotension or hypertension, tachypnea, increased respiration work, and less than 85% of oxygen saturation [15••, 23].

Children who used extracorporeal devices were referred for possible adverse effects: falls, syncope and presyncope, unplanned extubation, surgical wound bleeding, hemodynamic instability, ischemia, or impairment of a device structure [18].

The frequency of EM-related complications is low, around 2.5%, with the most frequent being a decrease in oxygen pulse saturation, tachypnea, and vomiting [15••]. It is suggested to evaluate the variability of vital signs before, during, and up to 15 min after the interventions.

Main EM interventions indicated in the PICU

It is recommended that physical activity should be individualized according to the clinical and functional condition of each child, availability of materials/equipment, medical indication, age, and wishes of the child/family [22].

The activities described are varied and may include ball games, circus arts (swings, juggling), games (darts, rings, shuttlecocks), archery games, self expression (dance, relaxation, gymnastics, stretching), fighting activities [23], and bodybuilding video games (bicycle exercise, step, swing balls, dumbbells) [1]. The exercises that use virtual reality in the PICU encourage antigravitational movements, especially of upper limbs [22].

Early mobilization should include activities focused on increased physical function and muscle strength, such as strengthening exercises, bed mobility, transfers, pre-walking activities, and walking itself [1]. For bedridden patients with suspected venous thrombosis, deambulation, and mobilization (active and passive) of non-affected members, these activities should be advocated. Use of intermittent compression devices in the lower limbs is indicated associated to the mobilization [24].

In children awaiting lung transplantation, it is suggested to initiate mobilization by means of muscle-strengthening exercises and mobilization in the supine position (calf pump, heel slip, stretching of upper limbs, and range of motion exercises). The evolution of these exercises should include seated activities on the bedside for the purpose of global strengthening (upper limbs, lower limbs and trunk), including raising of legs and upper limbs, and movements of ankles. Evolving to

activities in the standing posture will contribute to ambulation [19].

It is recommended that the physiotherapist should optimize motor ability, functional mobility, strength, and endurance to improve the patient's participation in functional activities appropriate for his/her age group. It can implement treatment interventions for global and/or specific deficits, considering the child's age range, which include functional positioning, balance, strength, endurance, gait, and coordination. Depending on the age range, it can promote interventions aimed at the prevention and treatment of NPMD changes, such as stimulation to motor coordination, visual perception skills, appropriate play for age and self-care activities, and modifying or adapting tasks to promote functional independence of the child [20•].

Some equipment or devices frequently used in rehabilitation can encourage active movement and participation of the child and contribute to the improvement of the quality and assertiveness of the movement. These materials should support rehabilitation interventions and patient safety. The assistive devices can also aid the multiprofessional team in the safety of the procedures when performing the possible forms of mobilization/transfers of the child at different moments, not being exclusive to the interventions of physiotherapy.

Examples of equipment facilitating the mobilization are electric bed with chair positioning (inclination around 70°), tilt tables, wheelchairs with spatial slope, seat devices for smaller children, cube chair (for trunk and head control training), cycle ergometers, and bicycle with functional electrical stimulation [20•].

Frequency and time of EM

Previous studies recommend EM programs with physiotherapy interventions in 30-min sessions to be performed once a day from Monday to Friday. However, the frequency and duration of the procedures should be influenced by the patient's level of awareness and cooperation, that is, they are suggested to be treated in an individualized way [13].

For activities with exercises that use games with virtual reality, a minimum of 10 min a day is suggested, meaning twice a day [14••]. The daily duration (in minutes) of the EM sessions should increase according to the level of awareness and cooperation of the child, so that for patients with deep sedation, less than 30 min of activity is suggested; for non-cooperatives, around 30 min; for cooperatives of 30 to 40 min; for cooperative wandering, around 45 min.

The weekly frequency should also increase according to the level of sedation of the patient, suggesting less than once a day (deep sedation), once a day (non-cooperative), twice a day (non-ambulatory cooperatives), and more than twice a day (ambulators) [13].

How to evaluate the effects of EM? Which markers?

There is a gap in the best appropriate instruments to evaluate the effects and benefits of EM in pediatrics. Some authors suggest the evaluation of the increase in quality of life, patient and caregiver satisfaction at hospital discharge, protocol safety, higher degree or number of activities of the upper limbs during the intervention period in relation to the rest of the day, muscle strength, use of the accelerometer for bedridden patients, walking distance during walking, palmar grip strength, among others [18, 20•, 21].

It is also suggested to monitor other goals to be achieved by patients, such as positioning and range of motion; tolerance to handling and interaction with the physiotherapist/team; tolerance to orthostatism in specific structure (parents' lap, bed); the ability to carry out activities appropriate to their age; participation in the daily routine, such as walking in the cart and going to hospital school [18, 26, 27••, 28••].

It is recommended to apply scales that contemplate muscular strength and mobility (boy function), for example, the Medical Research Council (MRC) scale score and handheld dynamometers; motor/cognitive, like the Functional Status Score for the ICU (FSS-ICU) [27]; the evaluation of the level of sedation, such as the Ramsay scale or COMFORT, aiming at optimizing sedation and avoiding delirium (which can be evaluated by all the critically ill children for delirium using the Preschool Confusion Assessment Method (psCAM, 6 months to 5 years) (CAPD; all ages)) or the Pediatric Confusion Assessment Method (pCAM, 5 years and older), which can effectively identify both hypoactive and hyperactive delirium [29–31].

TEN REASONS TO INDICATE EARLY MOBILIZATION IN PICU
1. Improves physical function
2. Decreases mechanical ventilation time
3. Decreases the incidence of delirium
4. Improves sleep quality
5. Improves cardiorespiratory function
6. Reduces the risk of osteoneuromuscular deformities
7. Improves cognitive, motor and psychological performance
8. Improves patient and family satisfaction
9. Improves the satisfaction of the multiprofessional team
10. Improves quality of life after hospital discharge

Fig. 1. Ten reasons to indicate early mobilization in PICU.

Monitoring of other markers, such as serum lactate and creatine phosphokinase may be necessary in more severe cases where there is no positive evolution (gain of functional independence) or in those with functional worsening after the start of the EM program. Nutritional and electrolyte evaluation (especially of calcium,

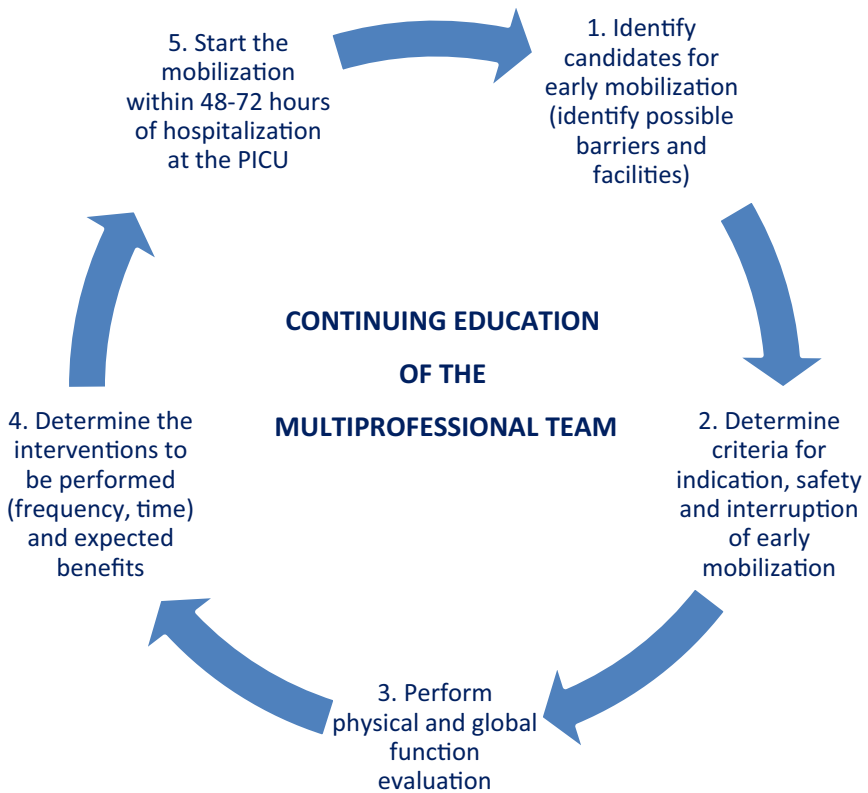

Fig. 2. Five steps for the implementation of an early mobilization protocol in PICU.

sodium, magnesium, phosphorus, and vitamin D, which present correction with loss of mass and muscular function) should be considered in these cases.

Benefits demonstrated in the literature

Studies [11, 32, 33••] demonstrate an increase in physical function, reduction of ICU length of stay, reduction in mechanical ventilation time and delirium frequency, improvement of the sleep-awake cycle, reduction of hospitalization hospital costs, increased family, and health team satisfaction (Fig. 1).

When performed with virtual reality games, it was observed that there is a strong correlation of the time of use of the tool by the child with the perception of fun observed by the parents [28••]. The implementation of a progressive EM protocol in PICUs in conjunction with delirium bundle and sedation protocol was associated to a reduction in the prevalence of delirium [34].

It is suggested to implement a protocol in an individualized way, according to the characteristics of each unit of care (Fig. 2).

Conclusion

Confidence in the multiprofessional team, a collaborative environment, and belief in the evidence in favor of EM can facilitate adherence to EM protocols. Teamwork and a guideline-oriented approach may optimize safety and maximize the positive effects of EM in pediatrics. The population in PICU is heterogeneous in age and diseases, requiring EM protocols that could be adapted to the individualized for each patient's goals. There is a gap in methods of functional evaluation in pediatrics that can guide interventions and enable the increase of motility function in children.

Compliance with Ethical Standards

Conflict of Interest

All authors declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

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